

From Forest Nursery Notes, Summer 2009

55. An on-line knowledge center for water and nutrient management for the nursery and greenhouse industry. Lea-Cox, J. D., Zhao, C., Ross, D. S., and Bilderback, T. E. *Acta Horticulturae* 801:693-699. 2008.



Acta
Horticulturae
Home

Login
Logout
Status

Help

ISHS Home

ISHS Contact

Consultation
statistics
index

Search

ISHS Acta Horticulturae 801: International Symposium on High Technology for
Greenhouse System Management: Greensys2007

AN ON-LINE KNOWLEDGE CENTER FOR WATER AND NUTRIENT MANAGEMENT FOR THE NURSERY AND GREENHOUSE INDUSTRY

Authors: J.D. Lea-Cox, C. Zhao, D.S. Ross, T.E. Bilderback, J.R. Harris,
Chuanxue Hong, T.H. Yeager, W.L. Bauerle, S.D. Day, A.G.
Ristvey, R.C. Beeson Jr., J. Ruter

Keywords: substrate, irrigation, fertilization, water management, pathogens,
Moodle, distance-learning

Abstract:

We have developed a web-based knowledge center for water and nutrient management and conservation, for the nursery and greenhouse industries. Increasing environmental concerns and legislation in the United States and other countries require that we take a more comprehensive approach to improving and integrating cultural best management practices, since these operations are typically intensive users of resources which are applied to relatively small land areas. The website (<http://www.waternut.org>) provides the general public with an overview of the project and a link to the knowledge center (<http://www.waternut.org/moodle/>), which provides access to more than twenty intensive learning modules over the internet, within a Moodle learning management framework. These learning modules have been designed to actively engage learners in topics on substrate, irrigation, surface water, nutrient and pathogen management, which are integral to formulating farm-specific strategies for effective water and nutrient management. Additionally, tools such as irrigation audits and water and nutrient management planning are covered in specific modules. Over fifty regulatory agency, industry and education professionals have been active in the developmental review of these resources, through face-to-face workshops and on-line reviews of content. By providing on-line access to in-depth learning modules through this knowledge center, we intend to reach out to many different audiences, to a comprehensive informational resource of best management practices, to increase the efficiency of resources used by commercial ornamental operations.

- ▶ **Full Text** (PDF format, 1866730 bytes)
- ▶ **Citation**

Download Adobe Acrobat Reader (free software to read PDF files)



URL www.actahort.org Hosted by K.U.Leuven © ISHS

NOTICE: THIS MATERIAL MAY
BE PROTECTED BY COPYRIGHT
LAW (TITLE 17, U.S. CODE)

An On-Line Knowledge Center for Water and Nutrient Management for the Nursery and Greenhouse Industry

J.D. Lea-Cox¹, C. Zhao², D.S. Ross³, T.E. Bilderback⁴, J.R. Harris⁵, Chuanxue Hong⁶, T.H. Yeager⁷, W.L. Bauerle⁸, S.D. Day⁹, A.G. Ristvey¹⁰, R.C. Beeson Jr.¹¹ and J. Ruter¹²

¹University of Maryland, Department of Plant Science and Landscape Architecture, 2120 Plant Sciences Building, MD. 20742, USA.

²University of Maryland, Maryland Cooperative Extension, 330 Montevue Lane, Frederick, MD. 21702, USA

³University of Maryland, Department of Environmental Science and Technology, 1431 AgEngineering Building, MD. 20742, USA

⁴North Carolina State University, Department of Horticultural Science, 64 Kilgore Hall, Raleigh, NC. 27695, USA

⁵Virginia Tech and State Polytechnic University, Department of Horticulture, 401C Saunders Hall, Blacksburg, VA. 24061, USA

⁶Virginia Tech and State Polytechnic University, Department of Plant Pathology, Physiology and Weed Science, 1444 Diamond Springs Road, Virginia Beach VA. 23455, USA

⁷University of Florida, Department of Environmental Horticulture, 2517 Fifield Hall, Gainesville FL. 32611. USA

⁸Clemson University, Department of Horticulture, 150 Poole Agricultural Center, Clemson, SC. 29634. USA

⁹Virginia Tech and State Polytechnic University, Department of Forestry, 228 Cheatham Hall, Blacksburg, VA. 24061, USA

¹⁰University of Maryland, Wye Research and Education Center, 124 Wye Narrows Drive, Queenstown, MD. 21658. USA

¹¹University of Florida, Apopka Research and Education Center, 2725 Binion Rd. Apopka FL 32703. USA

¹²University of Georgia, Coastal Plains Research Center, 0224 Horticulture Building, Tifton GA. 31794. USA

Keywords: substrate, irrigation, fertilization, water management, pathogens, Moodle, distance-learning

Abstract

We have developed a web-based knowledge center for water and nutrient management and conservation, for the nursery and greenhouse industries. Increasing environmental concerns and legislation in the United States and other countries require that we take a more comprehensive approach to improving and integrating cultural best management practices, since these operations are typically intensive users of resources which are applied to relatively small land areas. The website (<http://www.waternut.org>) provides the general public with an overview of the project and a link to the knowledge center (<http://www.waternut.org/moodle/>), which provides access to more than twenty intensive learning modules over the internet, within a Moodle learning management framework. These learning modules have been designed to actively engage learners in topics on substrate, irrigation, surface water, nutrient and pathogen management, which are integral to formulating farm-specific strategies for effective water and nutrient management. Additionally, tools such as irrigation audits and water and nutrient management planning are covered in specific modules. Over fifty regulatory agency, industry and education professionals have been active in the developmental review of these resources, through face-to-face workshops and on-line reviews of content. By providing on-line access to in-depth learning modules through this knowledge center, we intend to reach out to many different audiences, to a comprehensive informational resource of best management practices, to increase the efficiency of

resources used by commercial ornamental operations.

BACKGROUND

The ornamental (nursery and greenhouse) industry is a major economic force in US agriculture, which in 2002 had 4.82M acres in production, accounting for 15.4% of wholesale crop receipts, with an average net return of \$947 per acre (USDA, 2002). This industry is highly diverse in terms of production practices and the species of plants grown, with approximately 400 genera and more than 2000 species of ornamentals in production. Container-nursery and greenhouse systems differ radically from traditional agronomic-type agricultural operations in terms of how they use water and nutrients. This is because these industries produce plants in soilless substrates which differ markedly in how they retain water and nutrients in comparison to traditional soils. There is no doubt that we need to take more effective steps to manage and conserve resources, in general. In order to do this, we need to effectively coordinate our existing educational resources, to increase the knowledge and capacity of the diverse group of professionals that serve these industries, and identify the gaps in our knowledge that require further research.

The majority of ornamental plant material grown in the United States is produced in container-nursery or greenhouse operations. These operations are classified as intensive agricultural systems because they use a combination of expensive resources (labor, water, fertilizers, etc.) to produce plants in large numbers on small acreages. Water and nutrient management is complicated for these operations, for a number of reasons (Lea-Cox and Ross, 2001), including the fact that the nutrient efficiency of many species has not been adequately researched, especially for herbaceous and woody perennial species; the growth rate and hence the nutrient uptake of many species varies specifically with temperature, together with other environmental growth factors, especially water; nursery and greenhouse systems use a wide range of irrigation methods to grow different sizes of plants and species demanded by the marketplace; the nutritional requirements of this wide range of species means that producers rely on a variety of fertilization methods, including conventional, controlled-release, and soluble fertilizers, where appropriate; production times for annual species can range from weeks to month, whereas production times are typically from a few months (for herbaceous species) to years for woody perennials and large trees. Also, semi-closed or closed production systems require an advanced knowledge of plant health and pathogen management, which is often a deterrent to recycling water and nutrients.

The quantity and quality of water used by intensive agriculture are topics of national interest since clean water is a critical requirement to sustain natural and managed terrestrial and aquatic ecosystems. Non-point source (NPS) nutrient pollution is a leading cause of degraded water quality in the United States. Water and nutrient management have consistently ranked within the top five research priorities of grower organizations in the United States during the past decade (American Nursery and Landscape Association, 2004). Increasing public demands on water supplies and water treatment, the possibility of high nutrient (nitrogen and phosphorus) discharge rates to rivers and groundwater, and increasing legislative and regulatory requirements are all factors driving the need for efficient management of resources, to mitigate impacts on the environment. As agricultural and urban development intensifies over time, the ability of watersheds to process nutrients will be much more uncertain. Land-use change has been identified as the most significant local, regional, and global human impact on the hydrologic system (Bhaduri et al., 2000). Given the nationwide expansion of ornamental production and the intensive use of water and nutrients by these operations, we have to ensure that producers are familiar with the most current best management practices.

GOALS

The impetus to develop this knowledge center was to *integrate* our knowledge base of water and nutrient management together with information about substrate, surface water and pathogen-related issues. All of these inter-related knowledge areas directly or

indirectly impact better water and nutrient management decisions by producers of ornamental plants. The primary goal of this project is to educate and increase the knowledge base of those best management practices which will improve production efficiency and the conservation of water and nutrients. We want the knowledge center to provide up-to-date information for the implementation of water and nutrient best management practices and to change practice, if necessary, at the individual farm level. An awareness of the basic concepts that will improve the efficiency of use and the conservation of resources will directly affect our ability to reduce water use and non-point source pollution of our nation's watersheds.

INTRODUCTION

As extension and research faculty from six land-grant Universities in the Mid-Atlantic and Southern regions of the United States, we have developed this collection of educational materials, based on our combined knowledge and interaction with the industry over the past two decades. This internet-based resource comprises two areas: (A) a website (<http://www.waternut.org>) that provides general industry information to the general public (Fig. 1), and (B) a Moodle site (<http://www.waternut.org/moodle>) which provides password-protected access to the learning modules (Fig. 2). More than twenty-five modules cover various aspects of substrate, irrigation and surface water management, and nutrient and pathogen management. Each module (Fig. 3) provides in-depth information on specific topics (Fig. 4), in a user-friendly learning environment (Moodle, 2007). This knowledge center is a unique resource that is available and accessible to anyone with internet access. This project is funded through an Extension grant from the USDA-CSREES – National Integrated Water Quality Program (USDA, 2007b), to help achieve the larger goals of the USDA National Water Program (USDA, 2007a) and integrate with the goals of the Mid-Atlantic and Southern regional water quality programs. In addition, this Knowledge Centre is integrated with the National Extension Water Outreach Education (NEWOE, 2005a) project, and observes Best Education Practice Goals (NEWOE, 2005b).

TARGET AUDIENCES

Our distributed partner network includes county and regional based faculty in extension, and other educators at community colleges and universities, to provide them with the resources for student education, and outreach presentations to growers and other professionals in their local communities. We also directly target individual growers, consultants and other professionals in the nursery and greenhouse industry, who wish to fulfil personal and business development requirements through individual access to the Knowledge Center. The modules are also intended to help state and federal agencies to help educate industry professionals who are required to maintain continuing-education credits, as part of their certification process (e.g. nutrient management certification requirements; Maryland Department of Agriculture, 2007).

DEVELOPMENT APPROACH

Website

The website is designed to be a primary gateway to the knowledge center, but the information on this website is targeted at people who may not be familiar with the nursery and greenhouse industry and our goals, in terms of water and nutrient management. As such, general information about the industry in the SE United States is provided, with statistics from the six states who are primary partners in this endeavour. General regulatory information is also given on the website, since this is often a primary reason that other audiences initially search for information. The concept of 'best management practices' is also introduced, since the general public is unlikely to be familiar with this concept, as an integrated approach to the production of plants by commercial operations. We link to the learning modules in the Moodle site via a webpage that includes streaming

videos, to familiarize the user with Moodle and with a step-by-step explanation how to register as a user. We also briefly explain on the website how these modules can be used for accreditation and certification, with links to the various state and industry organizations who are our partners in this process. We also provide biographies of the faculty at the six land-grant institutions who have developed the learning modules.

Distance Learning Environment – Moodle

To provide a framework for the learning modules, we chose a web-based format for delivery, since professionals are routinely busy and widely dispersed throughout the region. Oftentimes, the time available for continuing education is outside of normal working hours, which also made a web-based format essential. We specifically chose to develop the modules within Moodle, since it is an extremely cost-effective and open-source learning management system (Moodle, 2007). The chief limitation for many on-line course developers is working within an environment that is user-friendly, not only for the client, but also the developer – and balancing the development issues with programmatic and long-term sustainability issues. It is probably the most important decision that we made as a development team, since the professional look and feel of the modules, together with ease of use and the functionality (e.g. navigation) of the final education experience is extremely important to the end-user (Lea-Cox et al., 2002; 2004). Of course, the integration of other tools functions within the software environment, such as ‘My course’ functions, discussion areas, blogs and all the tools that make the user feel part of the learning community are also extremely important, to ensure that the technology does not inhibit learning experience (Pallof and Pratt, 1999).

Learning Modules

The Distance Learning environment allows us to combine the rich text and graphic environment with the immediacy of delivery, in a continuously available setting. Within a password-protected courseware environment, the information ‘content’ can be systematically designed, such that learning materials are presented in a coherent and logical format. Learning management software (LMS) systems provide the educational designer with a large degree of design control and tool capabilities, together with user-tracking capabilities. It is for these reasons that LMS systems have become the de facto standard for distance learning in the web-based environment, rather than html web pages.

Within our Moodle site, each learning module covers the science or subject matter necessary to understand the concept or process (Figs. 3 and 4). As stated previously, we cover substrates, irrigation management, surface water management, nutrient and pathogen management from a number of different angles. Each module is designed to provide a user with the interactivity demonstrating key concepts and/or reinforces material through real-life problem situations. The Learner is actively engaged by accessing multiple types of media, such as text resources, hypertext links to external websites and PDF resources, photographs, graphic illustrations, PowerPoint slides and video clips, where appropriate. Each learning module also contains evaluation methods (self-assessment quizzes, games and assignments) that are designed to synthesize knowledge and comprehension.

Problem-Based as Well as Knowledge-Based

We have a number of modules that are entirely practical – two specific examples being an irrigation audit module, where the grower is guided through a specific protocol to optimize the performance of the irrigation system and another being a water and nutrient management planning module, which guides the grower through a process to write a site-specific best management plan for their operation. By using a problem-based learning approach and with guidance using the content in the module, learners can then analyze, synthesize and evaluate information, to enable them to design and implement a customized suite of best management practices. Practical assignments, usually using realistic case-study situations lead each learner through the process of inquiry. Each

assignment is designed to enable students to acquire higher-order cognitive skills, including application, analysis, synthesis and evaluation. The emphasis is on developing critical evaluation skills, which are prerequisites for creating and implementing site-specific management strategies.

EVALUATION AND IMPACTS

We need to continuously evaluate our progress by asking the question "How do these extension education activities affect decision-making, management practices, and behaviour changes among our growers or managers?" At the present time, many stakeholders in this industry do not have the resources available for them to make actively-engaged best management practice decisions, since these production systems differ so radically from traditional agronomic-type operations in terms of water and nutrient use. We hope that the knowledge provided will start to change this situation. Active self-evaluation techniques are built in at almost every level in each module. We cannot, and do not wish to monitor the decisions of every participant. Our wish is to facilitate the active learning process, so that the end-user can come to a rational decision on how to change practice for economic, environmental or personal reasons. We actively assess how this knowledge affects individual actions by providing anonymous on-line surveys at the end of every module, which we will use to renew and refine our content on a continuous basis. Ultimately, we hope that the development of the knowledge center will facilitate public policy education, individual action to improve water conservation and reduce runoff, thereby increasing the water quality of all these operations within the regions' watersheds, and improve our ability to form partnerships between cooperative extension and state and federal agencies.

Literature Cited

- American Nursery and Landscape Association, 2006. Horticultural Research Institute Research Priorities. <<http://www.anla.org/pdf/ResearchPriorities2005-RevisedAugust2005.pdf>>.
- Bhaduri, B., Harbor, J., Engel, B. and Grove, M. 2000. Assessing watershed-scale, long-term hydrologic impacts of land-use change using a gis-nps model. *Environmental Management* 26:643-658.
- Lea-Cox, J.D. and Ross, D.S. 2001. Clean Water Policy and the Rationale for Developing a Water and Nutrient Management Process for Container Nursery and Greenhouse Operations. *J. Env. Hort.* 19: 226-229.
- Lea-Cox, J.D., Varley, E.N., Ross, D.S and Tefteau, K.M. 2002. Using Web-Based Distance Learning Methods to Teaching Nutrient Management Planners. *HortTechnology* 12:736-740.
- Lea-Cox, J.D., Ross, D.S., Varley, E.N. and Tefteau, K.M 2004. A WebCT-Based Distance Learning Course to Teach Water And Nutrient Management Planners For The Nursery And Greenhouse Industries. *Acta Hort.* 641:101-109.
- Maryland Department of Agriculture, 2007. Office of Resource Conservation - Nutrient Management in Maryland. <http://www.mda.state.md.us/resource_conservation/nutrient_management/index.php>
- Moodle, 2007. Open-Source Course Management Software. <<http://moodle.org>>.
- National Extension Water Outreach Education, 2005a. <<http://wateroutreach.uwex.edu/>>.
- National Extension Water Outreach Education, 2005b. Best Education Practice goals <<http://wateroutreach.uwex.edu/beps/essential.cfm>>.
- Paloff, R.M. and Pratt, K. 1999. Building learning communities in cyberspace: Effective strategies for the online classroom. Jossey-Bass Inc., San Francisco, CA.
- United States Department of Agriculture, 2002. 2002 Census of Agriculture. <<http://www.agcensus.usda.gov/Publications/2002/index.asp>>
- United States Department of Agriculture, 2007a. National Water Program. <<http://www.usawaterquality.org/>>.
- United States Department of Agriculture, 2007b. National Water Quality Program.

<http://www.csrees.usda.gov/nea/nre/in_focus/water_if_waterquality.html>.

Figures

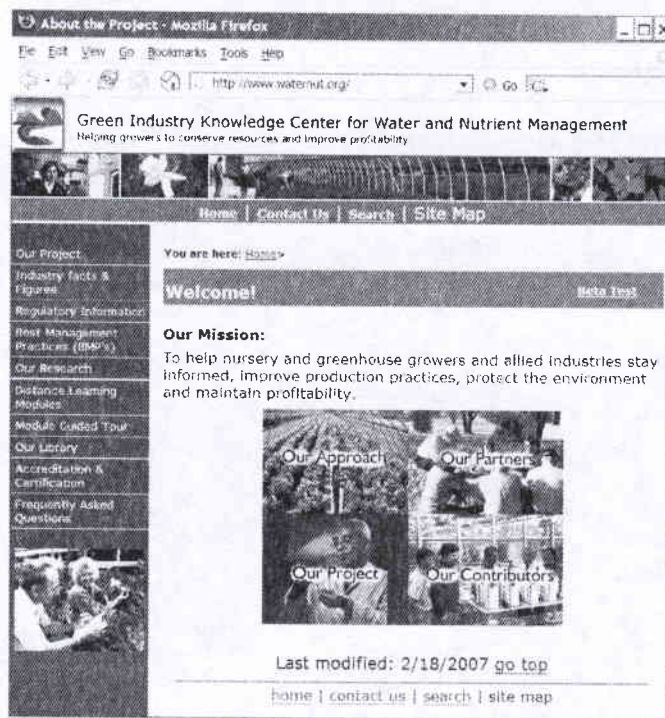


Fig. 1. Water and nutrient management website.

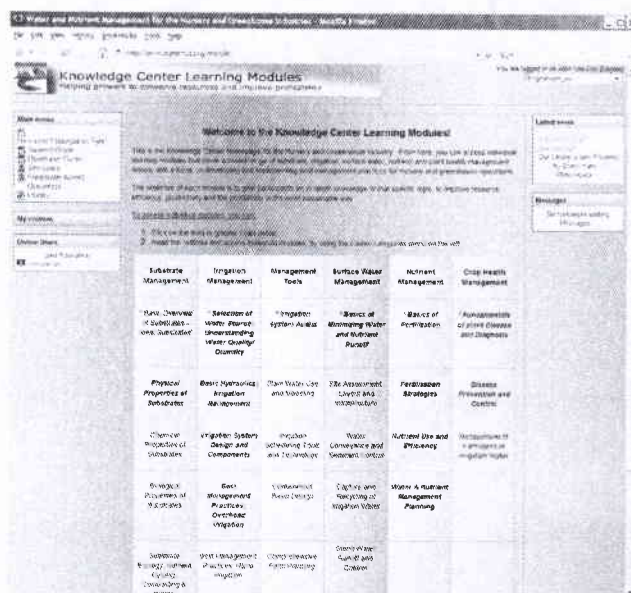


Fig. 2. Water and nutrient knowledge center homepage.

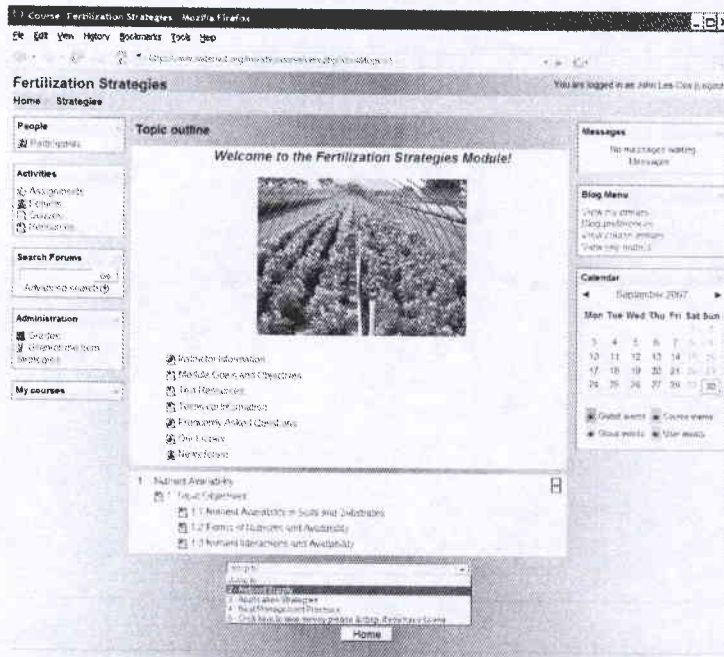


Fig. 3. Example module - fertilization strategies.

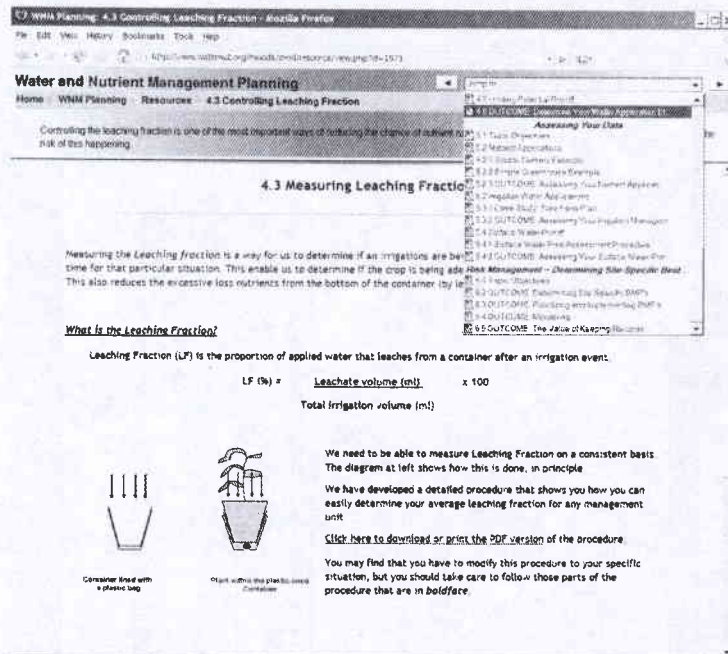


Fig. 4. Example content page and navigation options.